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An Assessment of the Fall Vedder-Chilliwack River Sport Fishery, 1988

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March 1990

Canadian Manuscript Report of
Fisheries and Aquatic Sciences
No. 2050

Fisheries and Oceans Pêches et Océans

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Fisheries and Aquatic Sciences 2050

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by

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90-04976/

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Cat. No. Fs 97-4/2050E ISSN 0706-6473

Correct citation for this publication:

Whyte, I.W. and N.D Schubert. 1990. An assessment of the fall Vedder-Chilliwack River sport fishery, 1988. Can. MS Rep. Fish. Aquat. Sci. 2050: 24 p.

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ABSTRACT

Whyte, I.W. and N.D. Schubert. 1990. An assessment of the fall Vedder-Chilliwack River sport fishery, 1988. Can. MS Rep. Fish. Aquat. Sci. 2050: 24 p.

The Vedder-Chilliwack River supports one of British Columbia's largest nontidal sport fisheries. During the fall, the fishery targets on coho salmon, although some effort has been directed towards chinook salmon since the river was reopened to the harvest of that species in 1984. Both populations are supplemented by releases of marked and unmarked hatchery reared smolts. This study assessed the angler effort, harvest and release in the Vedder-Chilliwack River from August 1 to November 30, 1988.

Separate estimates were made for river sections above and below Highway 1. Estimated effort above Highway 1 was approximately 97,000 angler hours, peaking in October at 54,000 angler hours. Estimated harvest above Highway 1 included 15,147 coho salmon (14,618 adults and 529 jacks), 688 chinook salmon (670 adults and 18 jacks), 18 chum salmon, 802 rainbow trout and 12 Dolly Varden char. Estimated releases included 5,629 coho salmon, 870 chinook salmon, 12,981 chum salmon, 1,530 rainbow trout, 35 steelhead trout, 26 cutthroat trout and 47 Dolly Varden char. An additional 20,500 angler hours of effort were estimated for the river below Highway 1.

Key Words: sport fishery, Vedder-Chilliwack River, coho salmon, harvest, release, angling effort.

RESUME

Whyte, I.W. and N.D. Schubert. 1990. An assessment of the fall Vedder-Chilliwack River sport fishery, 1988. Can. MS Rep. Fish. Aquat. Sci. 2050: 24 p.

La riviére Vedder-Chilliwack alimente l'une des plus importantes pêches sportives dans des eaux sans marée de la Colombie-Britannique. À l'automne, la pêche vise le saumon coho quoiqu'un certain effort soit dirigé vers la pêche du saumon quinnat depuis qu'elle a été rouverte dans cette rivière en 1984. Les effectifs des deux espèces ont été augmentés par des lâchers de saumoneaux marqués et non marqués d'eélevage. La présente étude porte sur une évaluation de l'effort de pêche sportive, des prises et des lâchers au cours de la pêche sportive effectuée du 1er August au 30 November 1988 dans la rivière Vedder-Chilliwack.

Les auteurs présentent des estimations pour chaque section de la rivière en amont et en aval de la route 1. En amont, l'effort estimatif de pêche sportive se situe à environ 97 000 heures avec une pointe de 54 000 en octobre. Les prises estimatives s'élèvent à 15 147 saumons cohos (14 618 adultes et 529 jeunes mâles précoces), 688 saumons quinnats (670 adultes et 18 jeunes mâles précoces), 18 saumons kétas, 802 truites arc-en-ciel, et 12 Dolly Varden. Les lâchers etimatifs comprennent 5 629 cohos, 870 quinnats, 12 981 kétas, 1 530 truites arc-en-ciel, 35 truites arc-en-ciel anadromes, 26 truites fardées, et 47 Dolly Varden. En aval de la route 1, l'effort estimatif de péche sportive s'élève à 20 500 heures.

Mots-clés: pêche sportive, rivière Vedder-Chilliwack, prises, effort de pêche sportive, saumon coho.

INTRODUCTION

The Vedder-Chilliwack River supports one of British Columbia's largest nontidal sport fisheries. The fall sport fishery for coho salmon (**Oncorhynchus kisutch**) was first assessed by a preliminary study in 1984 (DPA Group Inc. MS 1985). More detailed studies were conducted in 1985 (Hickey **et al.** 1987) and 1986 (Whyte **et al.** 1987). The current study continues that assessment for 1988.

The 1988 Vedder-Chilliwack River fall sport fishery was assessed for two reasons. First, comparative fishery assessments were made in 1985 and 1986, before and during the first returns of increased hatchery production of 1983 brood coho salmon. The 1988 survey provided a second assessment of the sport fishery response to elevated returns. Second, the retention of chinook adults (**O. tshawytscha**) has been permitted in the Vedder-Chilliwack River since 1984. This study provided a fourth assessment of that fishery.

This report describes the study design and field procedures and documents the results of the 1988 Vedder-Chilliwack River sport fishery survey. The report presents detailed monthly estimates of angler effort, harvest and release by species and mark type, and angler characteristics. The report concludes with an evaluation of methods and results relative to previous sport fishery surveys.

STUDY AREA DESCRIPTION

The Vedder-Chilliwack River originates in the Cascade Mountains of Washington State. The river then flows north across the International Boundary into Chilliwack Lake, then continues in a westerly direction for 61 kilometres, entering the Sumas River and subsequently the Fraser River near Chilliwack, B.C. (Fig. 1).

The study area was stratified by region, as described by Hickey **et al.** (1987) (Fig. 1). Region 1 extends from the Fraser River upstream to the Highway 1 bridge (km 4), including portions of the Sumas and Vedder rivers. Region 2 extends between the Highway 1 and Vedder Crossing bridges (km 16). Region 3 extends between the Vedder Crossing and Tamihi Creek bridges (km 26). Region 4 extends from the Tamihi Creek bridge to the sport fishing boundary at Sleese Creek (km 34).

1988 FISHERY REGULATIONS

The 1988 Vedder-Chilliwack River sport fishery was managed through area closures, size limits and species-specific daily and annual harvest limits (Ministry of Environment 1988). Salmon regulations allowed the retention of coho and chinook salmon but prohibited the retention of sockeye (**O. nerka**), pink (**O. gorbuscha**) and chum salmon (**O. keta**). The individual daily harvest limit for coho and chinook was four, of which up to four coho (two coho prior to September 27) and one chinook could be larger than 50 cm fork-length (FL). In addition, the annual harvest limit for chinook salmon was ten, and the retention of any salmon under 30 cm FL length was not permitted.

Trout regulations permitted a daily harvest of two, of which up to two could be cutthroat (**O. clarki clarki**) over 30 cm FL and one could be an adipose clipped (hatchery) steelhead trout (**O. mykiss**). Exceptions to the above included a daily harvest limit of four hatchery rainbow trout over 20 cm FL. The annual harvest limit of hatchery steelhead was ten.

In addition, the Chilliwack

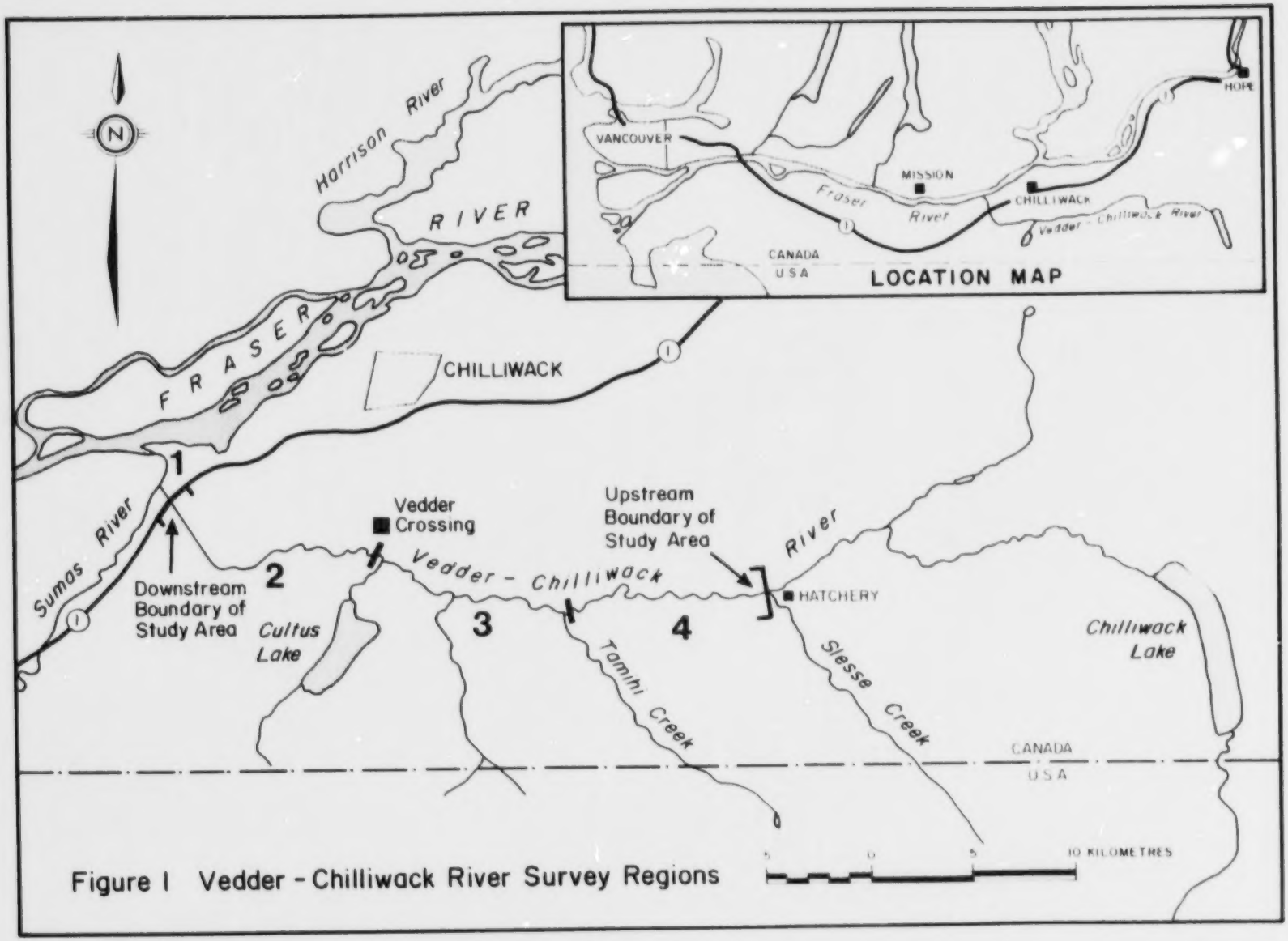


Figure I Vedder - Chilliwack River Survey Regions

River from Slesse Creek upstream to the outlet of Chilliwack Lake was closed to angling year round to protect wild steelhead trout.

METHODS

STUDY DESIGN

The 1988 Vedder-Chilliwack River sport fishery was assessed, using a roving study design (Malvestuto 1983), between August 1 and November 30, 1988. The study period was stratified by month with weekday and weekend or holiday day types. The sampling schedule included all weekend or holiday days and three weekdays per week. A single surveyor worked one of two randomly selected eight hour shifts which were adjusted each month to reflect decreasing day length. Data were recorded by region of angler encounter; however, for the purpose of analyses, all data were pooled.

On each sampling day, the surveyor travelled a predetermined route by vehicle with a constant rate of travel and a randomly selected start point and direction of travel. Anglers were approached on foot and interviewed regarding the length of time angling (to time of interview and additional expected time, to the nearest half hour), target species, number and species of fish harvested or released, gear type and, if the angler had fished the Vedder-Chilliwack River within two weeks, trip duration on the most recent trip. Marks (adipose fin, pelvic fin or maxillary clips) were not recorded due to surveyor error. When possible, the harvest was inspected to confirm species identification. An interview form was completed for each angler; however, if the angler was unresponsive or if response reliability was questionable, the form was voided.

Sample days consisted of five periods of one and one-half hours each. During three of these periods angler interviews were conducted in each of regions 2, 3 and 4. During each of the other two periods, the surveyor conducted "instantaneous" rod counts of the entire study area with counts allocated in proportion to the effort expected in each time block. No interviews were conducted during the rod count.

Angler effort in Region 1 was estimated from angler counts conducted from a Cessna 172 aircraft. These counts numbered ten in both August and September, eight in October and six in November. Ground surveys were not conducted in Region 1.

DATA MANAGEMENT

Data were stored and analyzed on an IBM-XT compatible microcomputer using a spreadsheet program. Monthly data files were sorted by weekday and weekend or holiday strata prior to analysis.

The data were verified in two ways. First, before computer entry, all data sheets were examined to ensure compliance with study procedures. Second, a sample of the spreadsheet files were verified against the field data sheets to ensure proper data entry.

DATA ANALYSES

The 1988 analytical methods were modified from those used in 1985 and 1986 to address estimation biases. The analytical approach adopted was similar to that employed in the Fraser River bar sport fishery program (DPA Group Inc. MS 1985). The study was designed to estimate angler effort, catch per unit effort and total catch (harvest and release). Angler effort was determined from rod counts, catch per unit effort from angler interviews, and total catch (harvest and

release) by combining the angler effort and catch per unit effort estimates.

Angler Effort

Region 1: Angler effort in Region 1 was estimated by applying the effort profiles for regions 2-4 (see below) to Region 1 angler counts. Variance was not calculated due to uncertainty in the assumption that effort profiles in the two areas were similar.

Regions 2-4: The mean proportion of the daily angler effort in each one and one-half hour time block was calculated by month/day-type stratum (e.g. September weekdays) from rod count data. The mean rod count for the peak time block (noon to 1:30 PM) was multiplied by 1.5 to estimate the mean angler effort (hours) for the peak time block. This value was then divided by the proportion of total daily effort in the peak time block to estimate mean daily total angler effort for the month/day type stratum. The total angler effort for the month/day type stratum was the product of the mean daily effort and the number of days in the stratum.

The detailed methodology, based on The DPA Group Inc. (MS 1985), follows. Variance calculations are detailed in Appendix 8.

1) Estimated total rods fishing ($\hat{R}_{hj}$), by hour and day type (weekday or weekend/holiday):

$$\hat{R}_{hj}^{*} = N_h / n_{hj} \sum_{k} r_{hjk}$$

2) Estimated proportion of daily angler effort occurring during the peak time block ($\bar{p}_{hj}^{*}$), by day type:

$$\bar{p}_{hj}^{*} = \frac{\hat{R}_{hj}^{*}}{\sum_{j} \hat{R}_{hj}}$$

3) Estimated mean rod count during the peak time block ($\bar{y}_{hj}^{*}$), by day type:

$$\bar{y}_{hj}^{*} = \sum_{k} \frac{y_{hj}^{*}{}_{k}}{n_{hj}^{*}}$$

4) Estimated angler effort (E_h), by day type, in hours:

$$E_h = N_h \frac{\bar{y}_{hj}^{*}}{\bar{p}_{hj}^{*}} \cdot 1.5$$

5) Estimated study period angler effort (E), in hours:

$$E = \sum_{h} E_h$$

where:

- N_h = total days of day type h (weekday or weekend/holiday) in the study period,
- n_{hj} = number of survey days on day type h during hour j,
- r_{hjk} = rod count on day type h at hour j on day k,
- $\hat{R}_{hj}^{*}$ = estimated total effort (hours) on day type h during the peak time block (j*),
- $y_{hj}^{*}{}_{k}$ = rod count during the peak effort period on day type h at all sites on day k,
- n_{hj}^{*} = number of instantaneous rod counts during the peak effort period on day type h at hour j*.

Catch Per Unit Effort

Catch per unit effort (CPUE) was calculated by species and mark group for each month and day type stratum using a total ratio estimator (Von Geldern, Jr. and Tomlinson 1973; Malvestuto 1983), i.e. the total observed catch was divided by the total observed effort (to time of interview). CPUE was calculated separately for harvested (HPUE) and released (RPUE) fish.

The mathematical relationships are reported below. Variance calculations are detailed in Appendix 8.

6) Monthly catch per unit effort for day type h ($CPUE_h$):

$$CPUE_h = \frac{\sum_i c_{ih}}{\sum_i t_{ih}}$$

where:

c_{ih} = catch to time of interview of angler i on day type h,

t_{ih} = angling hours to time of interview for angler i on day type h,

Harvest and Release

Total harvest and release, estimated by species and month and day type stratum, was the product of stratum effort and stratum HPUE or RPUE. The estimates were summed to estimate monthly and study period harvest and release. Catch was not estimated for Region 1 because regions 2-4 CPUEs were not considered representative of Region 1. The mathematical relationships are reported below. Variance calculations are detailed in Appendix 8.

7) Total monthly or study period catch (C):

$$C = \sum_h (E_h)\ (CPUE_h)$$

where:

E_h = estimated angler effort for stratum h,

$CPUE_h$ = catch per unit effort for stratum h,

Harvest Rate

Harvest rate by species in the Vedder-Chilliwack River was the ratio of the estimated harvest and the sum of the estimated harvest and escapement. Coho escapement data for 1988 were estimated by applying the ratio of the 1988 and 1987 escapements in fifteen Vedder-Chilliwack River tributaries to the total 1987 escapement. Data were provided Chilliwack River Hatchery staff (D. Buxton, pers. comm.). Chinook escapement was also estimated by the Chilliwack River Hatchery staff.

Angler Characteristics

The following angler attributes were summarized by stratum: mean angler day length (hours) for all anglers, from complete and incomplete trip interviews, and from the most recent trip in the previous two weeks; number of anglers targeting on each species; and gear type.

RESULTS

SURVEY EFFORT

One thousand and ninety-five angler interviews were conducted from August 1 to November 30, 1988, with

Table 1. Estimated angler effort by month and region in the Vedder-Chilliwack River, August 1 to November 30, 1988.

Region		August	September	October	November	Total
Region 1	Hours	3,708	4,454	12,003	377	20,542
	Days	1,106	1,693	2,269	92	5,160
Regions 2-4	Hours	5,973	9,011	54,014	27,633	96,631
	Days	1,782	3,426	10,210	6,756	22,174
All Regions	Hours	9,681	13,465	66,017	28,010	117,173
	Days	2,888	5,119	12,479	6,848	27,334

147, 236, 634 and 78 in August, September, October and November, respectively (Appendix 1). The study period comprised 85 weekdays and 38 weekend/holiday days, of which 40% and 68%, respectively, were sampled. The percentage of study period days surveyed ranged from 23% (November) to 50% (October) of the weekdays and from 44% (November) to 82% (October) of the weekend/holiday days.

ANGLER EFFORT

Daily Angler Effort Profiles

Profiles of daily angler effort for weekdays and weekend and holiday days are shown by month in Appendix 2. Over 40% of angler effort occurred between 10:30 AM and 3:00 PM.

Monthly Angler Effort

Region 1: Study period angler effort in Region 1 was estimated at 20,500 angler hours (5,200 angler days) (Table 1). Effort in Region 1 peaked in October at 12,000 angler hours (2,300 angler days), but declined sharply afterwards (Fig. 2).

Regions 2-4: Angler effort in regions 2, 3 and 4 totaled approximately 96,600 angler hours (22,200 angler days) (Table 1), with 95% confidence limits of ±13.3% (Appendix 3). Estimated effort by month totaled approximately 6,000, 9,000, 54,000 and 27,600 angler hours in August, September, October and November, respectively.

CATCH PER UNIT EFFORT

Harvest

Estimated HPUE for all species, expressed as fish per hour, are presented by month and day type in Appendix 4. Peak HPUE for combined marked and unmarked coho adults (0.2002) and jacks (0.0221) occurred during October weekdays and September weekends, respectively. Maximum HPUE for chi-

Table 2. Estimated catch by species and month in the Vedder-Chilliwack River (Regions 2-4), August 1 to November 30, 1988 (95% confidence limits in parentheses).

	August		September		October		November		Study Period	
A. Harvested Fish:										
Coho	0	(0)	718	(683)	9,272	(3,454)	4,628	(3,329)	14,618	(3,521)
Coho Jack	0	(0)	162	(383)	173	(438)	194	(348)	529	(582)
Chinook	0	(0)	0	(0)	619	(916)	51	(198)	670	(916)
Chinook Jack	0	(0)	0	(0)	18	(173)	0	(0)	18	(173)
Chum	0	(0)	0	(0)	18	(173)	0	(0)	18	(173)
Rainbow	357	(271)	248	(373)	182	(348)	15	(88)	802	(578)
Steelhead	0	(0)	0	(0)	0	(0)	0	(0)	0	
Dolly Varden	0	(0)	0	(0)	12	(85)	0	(0)	2	(85)
Cutthroat	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Whitefish	0	(0)	0	(0)	64	(298)	0	(0)	64	(298)
B. Released Fish:										
Coho	0	(0)	318	(465)	3,399	(2,011)	864	(711)	4,581	(2,064)
Coho Jack	0	(0)	140	(308)	485	(826)	423	(1,104)	1,048	(881)
Chinook	0	(0)	0	(0)	856	(1,034)	0	(0)	856	(1,034)
Chinook Jack	0	(0)	0	(0)	14	(90)	0	(0)	14	(90)
Chum	0	(0)	7	(64)	7,690	(3,315)	5,284	(2,267)	12,981	(3,316)
Rainbow	889	(633)	404	(514)	237	(596)	0	(0)	1,530	(1,010)
Steelhead	0	(0)	0	(0)	35	(145)	0	(0)	35	(145)
Dolly Varden	0	(0)	0	(0)	47	(279)	0	(0)	47	(279)
Cutthroat	26	(78)	0	(0)	0	(0)	0	(0)	26	(78)
Whitefish	0	(0)	0	(0)	67	(230)	0	(0)	67	(230)

Note: AD = Adipose fin clip

Figure 2. Distribution of Angler Effort on the Vedder - Chilliwack River Between August and November, 1988

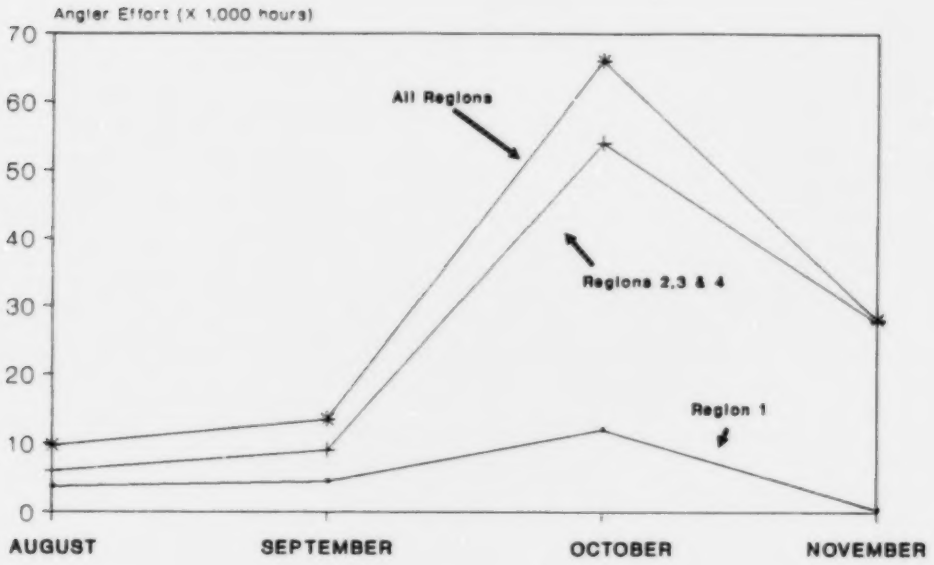
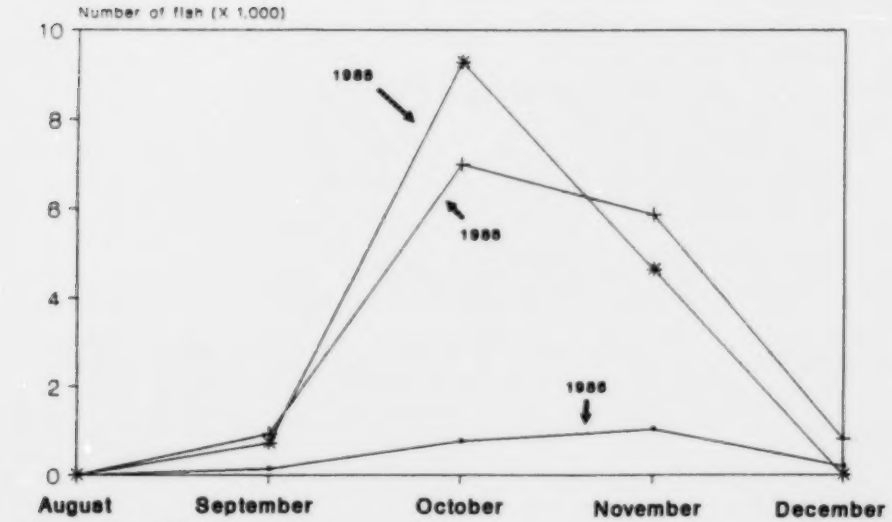


Figure 3. Estimated Monthly Harvest of Coho Salmon• from the Vedder-Chilliwack River, 1985, 1986 and 1988.



• adults only; marked and unmarked

Table 3. Summary by month of angler day length, preferred species and gear in the Vedder-Chilliwack River sport fishery, August 1 to November 30, 1988.

	August	September	October	November	Study Period
Mean Angler Day (hrs):					
- All anglers	3.97	4.55	5.97	4.96	5.32
- Incomplete trip	4.00	4.72	6.00	5.06	5.39
- Complete trip	3.35	2.63	5.29	4.09	4.37
- Previous trip [a]	3.45	3.27	4.96	4.11	4.33
Target Species (% of effort):					
- Coho	6.1	66.5	85.0	74.4	69.7
- Chinook	5.4	0.4	0.0	0.0	0.8
- Rainbow	30.6	3.4	0.2	0.0	5.0
- Any salmon or steelhead	57.9	29.7	14.8	25.6	24.6
Gear (% of effort):					
- Bait	49.7	53.4	20.4	15.4	31.1
- Bait and lure	20.4	20.8	20.2	25.6	20.7
- Fly	7.5	4.2	0.4	0.0	2.1
- Lure	22.4	21.6	59.0	59.0	46.0

[a] Most recent trip in the previous two weeks.

nook adults (0.0147) and jacks (0.0006) both occurred during October weekdays. The harvest also included chum salmon, rainbow or steelhead trout, Dolly Varden char and mountain whitefish.

Release

Estimated RPUE for all species are presented by month and day type in Appendix 4. Peak RPUE for coho adults (0.0631) and jacks (0.0206) occurred during October weekdays and September weekdays, respectively. Maximum RPUE for chinook adults (0.0175) and jacks (0.0006) occurred during October weekdays and weekends, respectively. Releases also included chum salmon, rainbow trout, steelhead trout, cutthroat trout, Dolly Varden char and mountain whitefish.

HARVEST

Total estimated harvest by species for regions 2-4 is presented in Table 2. The harvest of coho salmon was estimated at 15,147 (14,618 adults and 529 jacks). The maximum monthly harvest of coho adults (9,272) and jacks (194) occurred in October

Table 4. Summary of Vedder-Chilliwack River sport fishery characteristics, September through November, 1985, 1986 and 1988.

	1985[a]	1986[b]	1988
Angler effort (hours)	46,703	92,402	90,658
Coho salmon:			
- return to river	39,050	121,767	130,291
- harvest	1,936	13,776	14,618
- harvest per unit effort	0.0415	0.1491	0.1612
- harvest rate (%)	5.0	11.3	11.2
- catchability coefficient	1.1×10^{-6}	1.2×10^{-6}	1.2×10^{-6}
Chinook salmon:			
- return to river	1,110	3,792	15,258
- harvest	92	246	619
- harvest per unit effort	0.0020	0.0027	0.0068
- harvest rate (%)	8.3	6.5	4.1
- catchability coefficient	1.8×10^{-6}	7.1×10^{-6}	4.5×10^{-6}
Angler day length (hours):			
- all days	5.05	4.38	5.32
- incomplete trips	5.09	4.29	5.39
- complete trips	3.91	3.13	4.37
Target Species:			
- Coho	71.1	N/A	69.7
- Any salmon or trout	27.4	99.0	24.6
Gear:			
- Bait	56.4	92.1	31.1
- Bait and lure	9.2	0.5	20.7
- Fly	3.5	0.6	2.1
- Lure	30.8	6.8	46.0

[a] From Hickey et al. (1987)
[b] From Whyte et al. (1987)

and November, respectively. The ratio of observed (examined) to estimated coho harvest averaged 2.4% and 3.0% for adults and jacks, respectively (Appendix 5).

The harvest of chinook salmon was estimated at 688 (670 adults and 18 jacks). The maximum monthly harvest of chinook adults (619) and chinook jacks (18) occurred in October.

The harvest also included 18 chum salmon, 801 rainbow trout, 12 Dolly Varden char and 64 mountain whitefish.

RELEASE

Total estimated release by species for regions 2-4 is presented in Table 2. The release of coho salmon was estimated at 5,629 (4,581 adults and 1,048 jacks). The maximum monthly release of coho adults (3,399) and jacks (485) occurred in October.

The release of chinook salmon was estimated at 870 (856 adults and 14 jacks). All were released in October.

An estimated 12,981 chum salmon, 1,530 rainbow trout, 35 steelhead trout, 26 cutthroat trout, 47 Dolly Varden char and 67 whitefish were intentionally released in 1988.

HARVEST RATE

Coho adults were harvested at an estimated 11.2% in the 1988 Vedder-Chilliwack River sport fishery (Table 4). Escapement data were unavailable for coho jacks. Chinook adults and jacks were harvested at 4.1% and 3.5%, respectively.

ANGLER CHARACTERISTICS

Angler characteristics are provided for each month and day type stratum in Appendix 6 and by month and study period in Table 3.

Angler Day Length

Angler day length averaged 5.32 hours for all anglers interviewed during the study period. A difference was noted in the average angler day length between anglers who had completed their trips and those who were still angling at the time of interview. Only 7.2% (80) of the anglers interviewed had ceased angling for the day at the time of the interview. These anglers reported fishing an average of 4.37 hours. The remaining anglers (1,024), interviewed during their trip, estimated they would fish for an average of 5.39 hours.

Mean angler day length in October was substantially higher than in other months. Angler day length estimated from complete and incomplete trip interviews averaged 5.29 hours and 6.00 hours, respectively.

Anglers were asked if they had fished within the previous two weeks and, if so, how long they had fished on the most recent trip. The mean angler day length reported for previous trips was 4.33 hours, peaking in October at 4.96 hours.

Target Species

Almost without exception, respondents angled for either coho salmon (69.7%) or "any salmon or trout" (24.6%). During August 30.6% of the respondents angled for rainbow trout.

Gear Type

Anglers used lures (46%), followed by bait (31.1%), bait and lures (20.7%) and flies (2.1%). Bait was most commonly used in August and September, while lures were much more common in October and November.

DISCUSSION

OVERVIEW OF THE FALL FISHERY

Coho Salmon

The fall Vedder-Chilliwack River sport fishery was assessed between September and November in 1985 (Hickey et al. 1987) and 1986 (Whyte et al. 1987). The sport fishery expanded dramatically between 1985 and 1986 in response to a tripling in coho abundance resulting from increased hatche-

ry production (Table 4). Over those two years, angler effort and coho adult harvest rate doubled, coho adult harvest increased thirteenfold (Fig. 3) and HPUE increased almost fourfold.

Between 1986 and 1988, hatchery production stabilized and, as a result few changes were noted in the sport fishery. Coho abundance increased by only 7%, with similar increases in coho harvest and HPUE. The harvest rate and catchability of coho adults were virtually identical over the two years, although caution is urged in the interpretation of these parameters. Both were based on escapement estimates which were derived using a new technique in 1988. Interannual comparisons, therefore, may not be appropriate.

The overall proficiency of Vedder-Chilliwack River anglers may have improved between 1986 and 1988. The proportion of anglers who had retained a salmon (to time of interview) increased from 0.240 to 0.287 (Appendix 7), a 20% increase despite an increase in abundance of only 7%.

Chinook Salmon

The estimated harvest of chinook adults increased over sixfold between 1985 and 1988, from 92 to 619, respectively (Table 4). Most of the observed increase was attributable to changes in abundance, which increased from 1,100 in 1985 to 15,300 in 1988. Chinook catchability and harvest rates declined substantially over the same period. This decline may reflect a reluctance by the anglers to forego the opportunity to fill the daily harvest quota with coho salmon by harvesting a white flesh chinook, an assumption supported by two observations. Very few anglers targeted specifically on chinook salmon, and the release of chinook adults (856) exceeded the harvest (670) by 28% (Table 2).

Angler Day Length

Estimation of angler day length required the angler to accurately recall trip length to the time of interview and, if still fishing, to accurately project subsequent trip length. A difference was noted in angler day length estimated from complete and incomplete trip interviews, with the latter exceeding the former by over one hour (Table 3). Similar differences were noted in previous years (Hickey **et al.** 1987; Whyte **et al.** 1987).

The ability of anglers to recall trip length and to estimate subsequent trip length was evaluated in the lower Fraser River bar sport fishery in 1989 (DFO unpublished). While anglers were able to recall trip length with reasonable accuracy, there was a large positive bias when they attempted to estimate subsequent trip length. On average, anglers overestimated subsequent trip length by almost three hours, with some anglers overestimating by as much as ten hours. Only 9% of the anglers underestimated subsequent trip length.

We compared mean angler day length estimated from complete trip and previous trip interviews. The two estimates differed by an average of only two minutes (Table 3), supporting the above findings. For the purpose of this report, therefore, only complete trip interviews were used to estimate angler day length.

Changes in mean angler day length over the 1985-88 assessment period may reflect regulation changes which increased the maximum permissible daily angler harvest limit. In 1985, anglers were permitted a daily harvest of two coho salmon over 50 cm FL. The limit was increased to four from October 11 to November 30, 1986 and from September 27, 1988 to March 15, 1989. In 1985, angler day

length decreased between September and November. In 1986 and 1988, angler day length in October and November increased coincident with the regulation change. These observations suggest that the average angler was willing to spend more time on the river when permitted the opportunity to retain more fish.

ESTIMATION OF EFFORT

The 1985-88 Vedder-Chilliwack River sport fishery assessment studies estimated angler effort from profiles of the estimated proportion of the daily effort which occurred in short time blocks (either one or one and one-half hours). The use of shorter time periods relative to other studies (Malvestuto et al. 1978) provided two advantages. First, estimation accuracy was improved because error generated by the assumption that angler use was uniform over long periods was avoided. Second, estimation precision was improved because the instantaneous rod counts were conducted during the same time block, which was coincident with the maximum daily angler effort.

The 1985-86 daily effort profiles were generated from angler estimates of trip length to time of interview and, if still fishing, of subsequent trip length. There were two potential biases in this procedure. First, due to the systemmatic nature of roving surveys, the probability of contacting an angler was proportional to trip length (Lucas 1963; Sinclair and Morely 1975). This length of stay bias would mask short term variations in the daily effort profile, such as increases between 4:00 PM and dusk when anglers arrive after work. While this bias would effect the apparent pattern of daily effort, it would have little impact on the stratum effort estimate. Second, as noted previously, anglers contacted while angling may over-estimate total trip length. Over-estimation of subsequent trip length would skew the profile toward the latter part of the day. Because this would reduce the apparent proportion of the daily angler effort during the peak time block, this bias would result in the overestimation of angler effort. The degree of estimation bias would be dependent upon the magnitude of angler overestimates of subsequent trip length and would vary between strata. While the magnitude of 1985-86 effort overestimation was unknown, the similarity in effort profiles in the three years suggests it may have been minor.

The 1988 study design was changed to improve estimation accuracy by eliminating these biases. A consequence of improved accuracy, however, was a loss in precision resulting from the reduced sample size. The confidence limits about the effort estimate increased from an average 9.4% in 1985-86 to 13.3% in 1988. Consequently, relative to 1988, the precision of the effort estimate declined but the probable positive bias in the 1985-86 estimates was eliminated.

ESTIMATION OF CATCH

CPUE was estimated in 1985 and 1988 using a total ratio estimator (Von Geldern, Jr. and Tomlinson 1973; Malvestuto 1983) and in 1986 using a weighted mean of ratios estimator (Malvestuto 1983). While the latter is more appropriate to the assessment of angling quality or fish abundance rather than harvest, it was used in 1986 because the large increase in angling effort prevented proportionate sampling on high effort days. Although angler effort remained high in 1988, the survey was designed to sample anglers within each time period in proportion to total daily effort. We recommend the use of a total ratio estimator for future studies.

Differences in precision between the 1985-88 harvest estimates was assessed by comparing the confidence limits about the annual harvest estimates for the major groups. The confidence limits were 18%, 37% and 24% of the estimates in 1985, 1986, and 1988, respectively. The 1985 value was not valid, however, because the precision of the effort estimate was overstated by the methodology employed. Precision improved in 1988, despite a reduction in the precision of the effort estimate in that year. Improved precision reflected the use of the total ratio estimater for calculating CPUE.

SUMMARY

1. The fall coho sport fishery in the Vedder-Chilliwack River was assessed in 1985, 1986 and 1988. The 1985 assessment provided base line information prior to the first major return of enhanced coho production. The 1986 assessment evaluated the fishery impact of major enhanced returns. The 1988 survey provided a second assessment of the sport fishery response to elevated returns.

2. The fall coho sport fishery in the Vedder-Chilliwack River was assessed, using a roving creel study design, between August 1 and November 30, 1988. Angler effort was estimated both above (regions 2-4) and below (Region 1) Highway 1; catch was estimated only above Highway 1.

3. A single surveyor, working 34 weekdays and 26 weekend and holidays days, recorded the following during 1,095 angler interviews: length of time angling, number and species of fish harvested or released, target-species and gear type.

4. Angler effort was estimated by applying instantaneous rod counts to effort profiles also generated from rod counts.

5. Study period angler effort in regions 2-4 totaled 96,631 angler hours, with 95% confidence limits of ± 12,834 angler hours. An additional 20,542 angler hours were estimated in Region 1.

6. Study period harvest totaled 15,147 coho (14,618 adults and 529 jacks), 688 chinook (670 adults and 18 jacks), 18 chum, 802 rainbow trout and 12 Dolly Varden char.

7. Study period releases totaled 5,629 coho (4,581 adults and 1,048 jacks), 870 chinook (856 adults and 14 jacks), 12,981 chum, 1,530 rainbow trout, 35 steelhead trout and 47 Dolly Varden char.

8. The 1985-88 sport fishery assessment studies estimated angler effort from profiles of the estimated proportion of the daily effort which occurred in short time blocks. The 1985-86 daily effort profiles, generated from angler estimates of trip length, were biased and may have produced overestimates of angler effort. The bias was corrected in 1988 by estimating the daily effort profiles directly from rod counts.

ACKNOWLEDGEMENTS

Funding for this project was provided by Employment and Immigration Canada under the Canadian Jobs Strategies, Job Development Program. The Department of Fisheries and Oceans,

New Westminster provided a portion of the operating expenses as well as logistical support throughout the project.

J. Hogarth conducted the field work for this study. Computer data entry was performed by D. Kientz using a custom data entry program written by G. Zeiss of The DPA Group, Inc. The study area overflights were piloted by C. Muglich and R. Pollock of Air Southwest Ltd., Chilliwack, B.C.

The manuscript was reviewed by C.R. Harrison and D.G. Hickey. S. Gramchuk drafted the figures.

Appreciation is extended to all the Vedder-Chilliwack River sport fishermen who provided the valuable information which formed the basis of this study.

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Appendices

Appendix 1. Vedder-Chilliwack River sport fishery survey effort, August 1 to November 30, 1988.

	Aug	Sept	Oct	Nov	Total
Shifts worked:					
Weekdays	9	10	10	5	34
Weekends	6	7	9	4	26
Days in month:					
Weekdays	22	21	20	22	85
Weekends	9	9	11	9	38
Percentage of days worked:					
Weekdays	41	48	50	23	40
Weekends	67	78	82	44	68
No. of anglers interviewed:					
Weekdays	47	100	311	29	487
Weekends	100	136	323	49	608
Total	147	236	634	78	1,095

Appendix 2. Angler effort profiles for the Vedder-Chilliwack River sport fishery, August 1 to November 30, 1988.

	Proportion of total daily effort in time period							
	August		September		October		November	
Time Period	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
0600-0730	0.092	0.051	0.116	0.058	0.080	0.118		
0730-0900	0.111	0.075	0.099	0.076	0.097	0.077	0.114	0.125
0900-1030	0.101	0.098	0.145	0.088	0.102	0.147	0.211	0.132
1030-1200	0.184	0.180	0.104	0.150	0.109	0.094	0.155	0.149
1200-1330	0.128	0.119	0.113	0.112	0.111	0.112	0.151	0.141
1330-1500	0.116	0.139	0.127	0.097	0.125	0.131	0.121	0.167
1500-1630	0.094	0.186	0.083	0.194	0.119	0.101	0.081	0.115
1630-1800	0.080	0.071	0.135	0.098	0.133	0.122	0.166	0.170
1800-1930	0.094	0.081	0.080	0.126	0.123	0.099		

Note: All times expressed as local time.

Appendix 3. Estimated angler effort in the Vedder-Chilliwack River sport fishery, August 1 to November 30, 1988 (95% confidence limits in parentheses).

	Region 1	Regions 2-4	All Regions
August:			
Weekdays	1,804	3,696 (1,318)	5,500
Weekends	1,904	2,277 (638)	4,181
All days	3,708	5,973 (1,092)	9,681
September:			
Weekdays	2,843	4,356 (2,095)	7,199
Weekends	1,611	4,655 (2,135)	6,266
All days	4,454	9,011 (2,626)	13,465
October:			
Weekdays	5,595	30,112 (8,328)	35,707
Weekends	6,408	23,902 (4,461)	30,310
All days	12,003	54,014 (8,487)	66,017
November:			
Weekdays	50	16,979 (16,967)	17,029
Weekends	327	10,654 (11,426)	10,981
All days	377	27,633 (12,226)	28,010
Study Period:			
All days	20,542	96,631 (12,834)	117,173

Appendix 4. Estimated harvest and release rates in the Vedder-Chilliwack River, August 1 to November 30, 1988.

	August		September		October		November	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
A. Harvest per unit effort (HPUE):								
Coho	-	-	0.0891	0.0672	0.2002	0.1357	0.1588	0.1813
Coho (AD)	-	-	0.0023	0.0015	-	-	-	-
Coho Jack	-	-	0.0136	0.0221	0.0028	0.0037	0.0077	0.0059
Chinook	-	-	-	-	0.0147	0.0074	0.0030	-
Chinook Jack	-	-	-	-	0.0006	-	-	-
Chum	-	-	-	-	0.0006	-	-	-
Rainbow	0.0234	0.1187	0.0180	0.0298	0.0004	0.0071	-	-
Steelhead	-	-	-	-	-	-	-	-
Steelhead (AD)	-	-	0.0071	-	-	-	0.0009	-
Dolly Varden	-	-	-	-	-	0.0005	-	-
Cutthroat	-	-	-	-	-	-	-	-
Whitefish	-	-	-	-	0.0016	0.0007	-	-
B. Release per unit effort (RPUE):								
Coho	-	-	0.0475	0.0239	0.0631	0.0627	0.0295	0.0341
Coho Jack	-	-	0.0206	0.0107	0.0123	0.0048	0.0201	0.0077
Chinook	-	-	-	-	0.0175	0.0138	-	-
Chinook Jack	-	-	-	-	-	0.0006	-	-
Chum	-	-	-	0.0015	0.1991	0.0709	0.2008	0.1760
Rainbow	0.1130	0.2072	0.0425	0.0470	0.0067	0.0015	-	-
Steelhead	-	-	-	-	-	0.0015	-	-
Dolly Varden	-	-	-	-	0.0016	-	-	-
Cutthroat	0.0069	-	-	-	-	-	-	-
Whitefish	-	-	-	-	0.0004	0.0023	-	-

Note: AD = Adipose clipped.

Appendix 5. Observed and estimated harvests of coho salmon from the Vedder-Chilliwack River, August 1 to November 30, 1988.

	Aug	Sep	Oct	Nov	Total
Coho Adults:					
Observed harvest	0	36	296	22	354
Estimated total harvest	0	718	9,272	4,628	14,618
Percentage observed	0.0	5.0	3.2	0.5	2.4
Coho Jacks:					
Observed harvest	0	8	7	1	16
Estimated total harvest	0	162	173	194	529
Percentage observed	0.0	4.9	4.0	0.5	3.0

Appendix 6. Angler characteristics in the Vedder-Chilliwack River sport fishery, August 1 to November 30, 1988.

	August		September		October		November	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
Number of interviews	47	100	100	136	311	323	29	49
Mean Angler Day (hrs)								
- All anglers	3.98	3.97	4.69	4.45	5.96	5.97	4.87	5.01
- Complete trip interviews								
Number	3	8	6	15	26	14	3	5
Hours	1.17	4.37	2.50	2.72	5.48	5.10	4.17	4.04
- Incomplete trip interviews								
Number	44	92	94	121	285	309	26	44
Hours	4.17	3.93	4.83	4.64	6.01	6.00	4.95	5.12
- Previous trip a								
Number	17	37	60	80	194	203	20	34
Hours	2.76	3.76	3.45	3.14	4.94	4.97	3.95	4.20
Target Species								
- Coho	6	3	71	86	266	273	20	38
- Chinook	0	8	1	0	0	0	0	0
- Rainbow	13	32	3	5	0	1	0	0
- Any salmon or trout	28	57	25	45	45	49	9	11
Gear								
- Bait	27	46	46	80	50	80	5	7
- Bait and lure	6	24	31	18	66	63	8	12
- Fly	4	7	1	9	0	1	0	0
- Lure	10	23	22	29	195	179	16	30

a. Most recent trip in the previous two weeks.

Appendix 7. Retention of coho and chinook salmon, to time of interview, by anglers in the Vedder-Chilliwack River sport fisheries, September to November, 1985-88.

Year	Month	Day Type	Number of Anglers Interviewed	Number of anglers retaining:					Percentage of Anglers Retaining Salmon
				No fish	1 fish	2 fish	3 fish	4 fish	
1985	September	Weekday	71	68	2	1	0	0	4.2
		Weekend	180	164	10	4	1	1	8.9
	October	Weekday	400	319	58	19	4	0	20.3
		Weekend	623	545	46	21	9	2	12.5
	November	Weekday	286	231	40	12	3	0	19.2
		Weekend	463	397	49	13	4	0	14.3
Total	Number:	-	2,023	1,724	205	70	21	3	14.8
	Percent:	-	-	85.2	10.1	3.5	1.0	0.1	
1986	September	Weekday	333	313	15	4	0	1	6.0
		Weekend	248	241	4	3	0	0	2.8
	October	Weekday	147	93	29	13	9	3	36.7
		Weekend	411	313	65	27	5	1	23.8
	November	Weekday	532	379	88	51	10	4	28.8
		Weekend	591	379	119	61	27	5	35.9
Total	Number:	-	2,262	1,718	320	159	51	14	24.0
	Percent:	-	-	76.0	14.1	7.0	2.3	0.6	
1988	September	Weekday	100	82	16	1	1	0	18.0
		Weekend	136	115	19	2	0	0	15.4
	October	Weekday	311	181	85	31	10	4	41.8
		Weekend	323	239	55	17	8	4	26.0
	November	Weekday	29	20	8	0	1	0	31.0
		Weekend	49	39	8	1	1	0	20.4
Total	Number:	-	948	676	191	52	21	8	28.7
	Percent:	-		71.3	20.1	5.5	2.2	0.8	

Appendix 8. Variance estimation procedures.

1. **CATCH (C):**

$$(1)\quad Var(C) = \overline{CPUE}^2 E^2 \left[\frac{Var(E)}{E^2} + \frac{Var(\overline{CPUE})}{\overline{CPUE}^2} + \frac{Var(E)Var(\overline{CPUE})}{E^2\overline{CPUE}^2} \right]$$

where: E = estimated study period effort (hours),
$Var(E)$ = variance of the estimated study period effort (see equation 2),
$\overline{CPUE}$ = estimated study period catch per angler hour,
$Var(\overline{CPUE})$ = variance of the estimated study period catch per angler hour (see equation 3).

2. **EFFORT (E):**

$$(2)\quad Var(E) = N^2 \left[\frac{\bar{y}_{j\cdot}}{\bar{p}_{j\cdot}} \right]^2 \left[\frac{Var(\bar{y}_{j\cdot})}{\bar{y}_{j\cdot}^2} + \frac{Var(\bar{p}_{j\cdot})}{\bar{p}_{j\cdot}^2} - \frac{2\,Cov(\bar{y}_{j\cdot},\bar{p}_{j\cdot})}{(\bar{y}_{j\cdot})(\bar{p}_{j\cdot})} \right]$$

where: N = total days in study period,
$\bar{y}_{j\cdot}$ = mean instantaneous rod count (at time period j*),
$Var(\bar{y}_{j\cdot})$ = variance of the mean rod count at time period j* (see equation 4),
$\bar{p}_{j\cdot}$ = proportion of daily angler hours occuring at the time of instantaneous rod count,
$Var(\bar{p}_{j\cdot})$ = variance of the proportion of daily angler hours occuring at time of instantaneous rod count (see equation 5).

3. **CATCH PER UNIT EFFORT (CPUE):**

$$(3)\quad Var(\overline{CPUE}) = \frac{1}{t} \left[\frac{(c_i - (\overline{CPUE})t_i)^2}{n(n-1)} \right]^{0.5}$$

where: A = number of anglers interviewed in stratum,
c_i = observed catch of angler i,
t_i = time to interview for angler i,
t = mean time spent angling (to time of interview),
n = number of anglers interviewed in stratum.

4. MEAN INSTANTANEOUS ROD COUNT ($\bar{y}_{j^*}$):

$$(4)\quad Var(\bar{y}_{j^*}) = \left[\frac{1}{n_{j^*}} - \frac{1}{N}\right] \sum_k \frac{(y_{j^*k} - \bar{y}_{j^*})^2}{n_{j^*} - 1}$$

where: n_{j^*} = number of instantaneous rod counts at time period j^*,

y_{j^*k} = instantaneous rod count on day k,

$\bar{y}_{j^*}$ = estimated mean rod count for time period j^*.

5. PROPORTION OF DAILY EFFORT AT TIME OF INSTANTANEOUS ROD COUNT ($\bar{p}_{j^*}$):

$$(5)\quad Var(\bar{p}_{j^*}) = \left[\frac{\hat{R}_{j^*}}{\sum_j \hat{R}_j}\right]^2 \frac{Var(\hat{R}_{j^*})}{\hat{R}_{j^*}^2} + \frac{Var \sum_j \hat{R}_j}{\sum_j \hat{R}_j^2} - \frac{2Cov(\hat{R}_{j^*}, \sum_j \hat{R}_j)}{(\hat{R}_{j^*})(\sum_j \hat{R}_j)}$$

where:

$$Cov(\hat{R}_{j^*}, \sum_j \hat{R}_j) = N^2 \left[\frac{1}{n_{j^*}} - \frac{1}{N}\right] \sum_k \frac{(r_{j^*k} \sum_j r_{jk}) - \frac{1}{n_{j^*}} \sum_k r_{j^*k} \sum_j r_{jk}}{n_{j^*} - 1}$$

$$Var(\hat{R}_{j^*}) = N^2 \left[\frac{1}{n_{j^*}} - \frac{1}{N}\right] \sum_k \frac{(r_{j^*k} - (\frac{1}{n_{j^*}} \sum_k r_{j^*k}))^2}{n_{j^*} - 1}$$

$Var \sum_j \hat{R}_j$ is analagous to above.

N = number of days in stratum,

n_{j^*} = number of interview sample days,

r_{jk} = rod count at time period j on day k,

r_{j^*k} = rod count at peak effort period j^* on day k,

$\hat{R}_{j^*}$ = estimated total effort (rod hours) during the peak effort period j^*,

$\sum_j \hat{R}_j$ = estimated number of rod hours over all hours and days.